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Construction and Sea Trials of a Contrawl Containerization System Prototype

Part I

Bond Architects and Engineers Ltd.

Fisheries Development Division
Fisheries and Habitat Management
Newfoundland Region
P.O. Box 5667
St. John;s, Newfoundland
A1C 5X1

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CONSTRUCTION AND SEA TRIALS OF A CONTRAWL CONTAINERIZATION SYSTEM PROTOTYPE

PART I

BOND ARCHITECTS AND ENGINEERS LTD.

FISHERIES DEVELOPMENT BRANCH
DEPARTMENT OF FISHERIES AND OCEANS
NEWFOUNDLAND REGION
P.O. BOX 5667
ST. JOHN'S, NEWFOUNDLAND
A1C 5X1

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BY

BOND ARCHITECTS AND ENGINEERS LTD.

FOR

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DEPARTMENT OF FISHERIES AND OCEANS
NEWFOUNDLAND REGION
P.O. BOX 5667
ST. JOHN'S, NEWFOUNDLAND
A1C 5X1

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Note: Copies of appendices to this report are available from:

Fisheries Development Division
Department of Fisheries and Oceans
P.O. Box 5667
St. John's, Newfoundland
A1C 5X1

1.0 INTRODUCTION

It has long been recognized that the current Canadian practice of storing fish, on offshore wet fish trawlers, in a penboard and stantion system results in a high percentage of less than top quality fish and significant loss of product due to poor processing yields. This is largely due to the difficulty of off-loading bulk or pen-stowed fish.

In an effort to overcome these problems, in the early 1970s, Fishery Products Limited (FPL), purchased three (3) new trawlers fitted with European boxes. Unfortunately for the company, the effort proved unsuccessful.

In 1980 Contrawl Limited approached FPL for assistance in the development of a novel trawler containerization system. The company agreed to support Contrawl's application through funding of a full scale prototype under the Enterprise Development Program (EDP). The BAE group was engaged by Contrawl to provide engineering for the prototype development.

The first prototype was subsequently fabricated and its operation demonstrated at the premises of Colda Mechanical Limited. During that period a second EDP project resulted in the development of a computer system which could be used to automate the Contrawl system loading and discharge operations.

This report provides details of the further and subsequent development of the Contrawl system, utilizating a significant modification to the in-hold mechanical system (developed by ACCO, Canadian Material Handling of Burlington, Ontario, in association with the BAE Group) but otherwise using the Original Contrawl concept.

Construction of the Contrawl prototype was substantially completed on the MV Atlantic Margaret by mid-October, 1985. Following a one (1) day sea trial and demonstration on October 19, 1985, the vessel made her first full fishing trip from October 21, 1985 to October 30, 1985 following installation of the system. That trip confirmed Contrawl's expectation that the system would function as intended in rough weather, that it would simplify the icing and storing operations, and deliver high quality fish to the plant.

The system has continued to be utilized and, up to March 31st, 1986, ten (10) regular fishing trips had been completed. Despite some earlier problems, which have since been corrected and other problems which have not as yet been remedied, (although solutions have been proposed), the containers have been filled every trip.

This report covers the utilization and effectiveness of the mechanical systems during the 5½ months of sea trials.

2.0 PROBLEMS AND SOLUTIONS

2.1 The Problems with Canadian Wetfish Trawlers

With few exceptions, until the past three to four years, Canadian trawlers have used a method of holding the catch in a penboard and stanchion system. IN this system, vertical stanchions set usually in a square pattern in the hold, are fitted with 8" wide corrugated aluminum penboards which fit into the stanchions to form the floor and walls of cubicle pens, typically 1.5m square and 1m deep.

As fish is taken on board, it is dressed (gutted), washed and director by conveyor to the hold where the crew places it into the pens

which are constructed from loose penboards previously stored in the hold. Using shovels, ice stored in other pens prior to leaving port is then added.

To this point, no significant damage has been caused by the on-board operations except, perhaps, that which occurs because of the necessity of someone having to walk on the fish in the hold in order to place penboards, etc. and the dropping of fish into the hold.

However, there are major problems subsequent to storage these include: (1) often the pens are too high resulting in loss of weight and softening of the flesh; (2) the fish/ice mass becomes hard and extremely difficult to remove from the pens and from the vessel; (3) discharge systems, including both conveyor/elevator systems and air system, cause significant damage.

The results are: (1) final quality is relatively low, especially of the older fish, thus restricting the product mix potential and resulting in relatively low average selling price and, (2) yield, which depends to a large extent on quality, is also low resulting in less product availability for sale.

2.2 The Solution - Criteria

Quite obviously, the solution will overcome the above mentioned problems. The solution objectives are to:

(a) Store the fish at such a height as to prevent excessive weight loss and softening of the flesh.

(b) Store fish and ice together to facilitate fish removal from the vessel without damage.

(c) Minimize or eliminate the storage of wetfish through the use of freezer trawlers or factory trawlers.

These objectives must, of course, be achieved at a cost which is less than the benefit provided. The higher the benefit/cost ratio, the more viable the solution.

All fish handling systems proposed in recent years, including European boxing systems, claim to achieve these objectives.

The Canadian fishing industry, now recognizing that it must convert its trawler fleet to systems using other than the penboard and stanchion method, has to choose between these various options. This report on the Contrawl System discusses and compares these alternatives.

2.3 The Solution - Tank Systems

Tank systems, utilizing large tanks for holding fish in a mixture of ice and water (chilled seawater or CSW) or for holding in refrigerated sea water (RSW), have been used with reasonable success, mainly for pelagic species. They are not considered appropriate for groundfish for the following reasons: (1) softening of the flesh is apparent after a few days in such storage; (2) either removal of the large tanks would be difficult and costly or the alternative of pumping the fish out would be damaging to quality; (3) there would likely be vessel stability problems. Tank systems are therefore not considered a viable alternative for groundfish trawlers.

2.4 The Solution - Freezer/Factory Trawlers

This solution is discussed in some small detail in the discussion paper on Factory Freezer Trawlers, published by the Department of Fisheries and Oceans in August, 1985. It is unfortunate that this paper compares new FFTs with state-of-the-art technology to new wetfish trawlers with old Canadian technology. This is a most inappropriate comparison.

While it is not the purpose or intent of this report to analyse FFT operations in any detail, nonetheless, we have included as Appendix "A" a revised Table 8 from the above-mentioned discussion paper which illustrates the probable effect on wetfish trawler operations of using boxing and the Contrawl containerization system while retaining intact the remainder of the Table 8 analysis.

These figures suggest strongly that FFTs are not at all more profitable than wetfish trawlers in fact they could be significantly less profitable if the assumptions used by the department relative to FFTs are correct.

2.5 The Solution Boxing Systems

Boxing systems are in general use in Europe and other areas and are currently being tried (again) by FPI and NatSea. There is no question that the proper use of 70 l or 90 l boxes (such as the PERSBOX) results in the delivery of excellent quality fish. Experience in Newfoundland, for example, has shown that up to 80% of the boxed fish from wetfish trawlers is of a satisfactory quality for use in "premium" packs. This compares with a typical figure of only 20% to 40% for fish held in a penboard and station system.

There are of course costs associated with the use of boxing

systems. These costs will vary with the degree of sophistication used to handle boxes on board and on shore, the style of box used, etc. but, in general, can be defined as follows:

(a) Boxing drastically reduces the volumetric capacity of a given hold space. The greater the mechanization used in the hold for refrigeration and to facilitate box handling the greater the loss of space and the greater the capital cost. Typically, a "boxed" trawler will hold 60 to 80% of that which the same trawler would hold in a pen system, or, for the same holding capacity, the hold would have to be 25 to 67% bigger. In any case, significant space is required outside the hold to store boxes to provide working space in the hold.

(b) Boxes are somewhat more expensive than penboards and stantions and their replacement rate is a significant factor, typically being as high as 30% per year.

(c) Unless rather sophisticated box handling equipment is used (in which case the capital cost of boxing systems rises significantly) the labour cost associated with boxing is quite high. It was probably this high labour cost that caused FPI to abandon its boxing efforts in the 1970's. Boxing was not adopted because of lack of interstructure on shore.

(d) In most boxing systems, icing is a serious problem due to the inefficiency of storing ice in the boxes or the extra space required if ice is stored separately.

(e) Because boxes are relatively small, inventory control becomes difficult since such large numbers required for a given trawler (typically, 4,000 to 5,000 per vessel). Loss, by theft, for example is relatively easy, both of box and fish in some situations.

(f) If boxes are used for holding and transportation on shore, insulation and/or refrigeration is required in the holding and transport facility to prevent excessive ice melting and subsequent loss of quality. Insulation of such small units is impractical in terms of relative cost and loss of volumetric efficiency.

2.6 The Solution - The Contrawl System

Recognizing that boxing systems did have serious drawbacks and having had considerable experience in the development of the Inshore Fish Handling Program (IFHP) for handling inshore fish in Newfoundland

with insulated, relatively large containers, the principals of Contrawl set about to devise a new and different trawler containerization system. The following criteria for such a system were established:

(a) Quality was recognized as a major consideration, perhaps the most important since both market price and yield (raw material productivity) depend heavily on good quality. Thus, delivered fish quality should be equivalent to that obtained from boxing systems.

(b) Similarly, hold capacity utilization should be at least equivalent to that achieved by boxing.

(c) The containerization system should be capable of keeping abreast of the maximum anticipation catching/gutting/washing rate. This was stated by Fishery Products Limited to be approximately 7 tons per hour. Maybe with large cod.

(d) The discharge rate should be at least as high as that achieved by boxing systems of air unloader systems. Thus, a minimum of 15 tons per hour was set for the discharge rate. However, lower discharge rates were encountered due to the prototype system.

(e) Based on experience using insulated containers on shore, it was felt that the container should be insulated and as large as possible to minimize purchase and handling costs) without significantly affecting quality. Hence, the existing prototypes have internal dimensions of approximately 1140 x 800 x 520mm or a capacity of 0.46m cubed, sufficient for approximately 270 kg of cod with ice ratio of 2:1 (fish to ice).

(f) The system must be safe in all sea condition suitable for fishing.

(g) T he system should be relatively easy to use (overcoming one of the major drawbacks of boxing systems which are typically awkward to use in the confined space of a fish hold).

(h) Ice storage and ice handling should both be relatively simple and convenient.

(i) Adaptable to existing wetfish trawler.

Criteria (c), (d), and (f) indicated and eventually led to a system which would handle more than one (1) container at a time in order to keep

operating speed of equipment within a safe range. Thus, although the Contrawl in-hold and on-deck systems were designed to operate at the extremely low speed of 0.05 mps at sea, the filling rate of 7 tons per hour was considered achievable. Multiple container handling at a higher speed in port will result in a very high discharge/re-load rate, equivalent to 100 tons per hour or more. A suitable shore-based system will, or course, be necessary to accommodate such a high rate of discharge.

A fuller description of the Contrawl System is provided in the following sections, the photographs of Appendix "B" and the As-Built Drawings. Briefly, the system has an in-hold mechanical system capable of traversing the hold just below the deck and of engaging three (3)* containers in a horizontal row at any level from just below the lifting system to the bottom row of containers in the hold. This system can therefore place a row of containers (which have been positioned in the hold by an above-deck system) from a position immediately below the hatchway to any other defined position in the hold or take a row of containers from one of these defined positions and place them in a position immediately below a (centralized) hatchway.

A factory deck lifter system brings rows of containers, in turn, from the position below the hatchway to a position in the hatchway where they may be conveniently filled with fish and ice from a conveyer. After filling, the reverse operation replaces the filled containers back in their original position in the hold.

* A full-size Contrawl System is expected to use four (4) containers in the row but the principal, operational requirements and constraints are the same.

Icing may be achieved in a variety of ways. For the present, a system of placing several bags of ice in each container (sufficient to ice the fish which will be placed in the container) has proven to be an acceptable solution for the operation of the prototype.

For loading and discharge from and to dockside the prototype utilizes an upper deck mounted, hydraulically powered, articulated crane, to handle containers one at a time. For a vessel which has a complete Contrawl System, it is anticipated that each of 2, 3 or 4 hold compartments (depending on vessel size, etc.) would discharge via a shore-based conveyor system. By such a method, a feasible as well as a similar loading rate from shore.

The prototype has a nominal capacity of sixty-three (63) containers in twenty-one (21) rows of three (3) containers. Two (2) additional rows could be added, one (1) immediately beneath the hatch covers and one on top of the hatch covers, if this additional capacity was seen to be desirable.

To operate the system, the top row of containers (a total of fifteen (15)) has to be stored outside the hold. There are a number of possible storage spaces on the Atlantic Margaret but it is proposed that these will be stored above the hatchways where they will cause little interference with other operations and be most readily placed in the hatchway for filling. A suggested storage system using penboards is shown in Appendix "D". The storing of these containers and their eventual positioning in the hatchway will be a completely manual operation. Since the containers will be empty (bags of ice stored therein having been first to be removed), this is not seen to be a difficult operation.

3.0 CONTRAWL SYSTEM PROTOTYPE

3.1 Construction

With the continued support of Fishery Products Limited (later, Fishery Products International) and that of the Department of Fisheries and Oceans, Fisheries Development Branch, DSS contracts were issued in October, 1984 to fabricate a prototype Contrawl System on an FPI trawler and to conduct sea trials to evaluate the system in terms of its operational usefulness, its stability and safety at sea and its anticipated costs and benefits.

Since Contrawl Limited is a small, and at this point, solely a development company, its contract called for subcontracting various components of the supply to five other companies:

(a) Xactics Limited of Saint John, New Brunswick, would inject foamed insulation into prototype containers which they had earlier supplied under the EDP Project.
Estimated Cost: $15,000.00

(b) Acco Canadian material Handling of Burlington, Ontario would construct and text the in-hole mechanical system (the Contrawl Mark II System);
Estimated Cost: $127,423. (since revised)

(c) The BAE Group, at St. John's engineering firm, would provide engineering design, construction drawings and supervision.
Estimated Cost: $60,000. (since revised)

(d) Newfoundland Marine Design Limited, a St. John's naval architectural firm would provide structural drawing and structural construction supervision.
Estimated Cost: $29,755. (since revised)

and

(e) Digital Electronics Services Limited (DES), a St. John's based electronics system maintenance company whose principal had been involved in the earlier EDP development of the automatic control system, would provide the manual and upgrade the automatic control systems and install both.
Estimated Cost: $44,510. (since revised).

A second contract to Fishery Products International provided for the installation of materials, labor costs and use and operation of the prototype system during subsequent sea trials at an estimated cost of $44,510. (since revised).

The fishing trawler, MV Atlantic Margaret, one of the old atlantic-class fishing vessels operating out of Marystown, was brought into the Burin refit center in mid February, 1985 for installation of the Contrawl System and necessary maintenance requirements.

Meantime, the "ACCO" system had been fabricated and successfully demonstrated at their shop in Burlington in March, 1985. The containers had been foamed in Saint John, New Brunswick, and construction drawings had been prepared by The BAE Group. During this period, DES had fabricated and tested much of the control system.

As was expected for this type of work the installation and on-board testing of the various components resulted in many minor changes to the design and show drawings. The reason for most of these was that viewing the various systems during or after construction together with discussions among engineers and installations technicians provided a better insight into the many rather complicated design problems that had been possible in the earlier design stage.

These changes are incorporated in the As-Built drawings.

Construction of the prototype was substantially completed by mid October, 1984 and, following a one(1) day sea trial and first full fishing trip following installation of the system on October 21, 1985, to October 30, 1985.

3.2 Operations

3.2.1 Mechanical Systems

The mechanical systems have performed well, for a prototype, in that the containers are held in a secure and safe condition even in very rough weather while permitting movement of containers between the hold and the factory deck. Thus, the concept is clearly valid. Wear and tear on the containers have, at times, proved to be insecure.

Several deficiencies have been noted which, in a new system design, would be corrected to ensure trouble-free operation. These include:

MATERIALS OF CONSTRUCTION

(a) Critical components, such as the end truck assemblies, lifters, etc. should be fabricated largely of stainless steel to eliminate problems caused by rusting and for longer life.

(b) Structural components should, perhaps, be either aluminum or galvanized steel. If of steel, they should be properly treated (sandblasted and epoxy coated, etc.) to prevent rusting. Bearing surfaces (guide surfaces) should have plastic wear pads attached to reduce friction and noise and, again, ensure longer life.

SYSTEM DESIGN

(a) To minimize utilization of space on the factory deck, chain takeups and drive shafts would be located below deck.

(b) Drive systems and electronical gear would be mounted on common bases and/or combined in "standard" motor control centers.

(c) All leading edges of the various pieces of moving equipment would be faired to prevent shock loading when entering guides, etc.

(d) The factory deck lifter system was specifically designed to permit moving the lifter aside to discharge containers through the upper deck. In a commercial installation, this system can (and would) be greatly simplified.

(e) Hatch beams require re-designing for better operation. These units may also require heavier drive motors as the existing units have all but worn out. In addition, the hatch beams will be designed to facilitate loading and discharge of the containers.

3.2.2 Hold Space Utilization

It is understood that the capacity of the forward hold compartment in the pen-type holding system was approximatly 85,000 lbs. Capacity of the installed system is 37/40,000 or less than 50%. However, this system is only three containers long, not four as it could be without the bucket elevator shaft, in which case the capacity would increase to about 57,000 lbs. or 67%. This is quite good considering that the vessel narrows dramatically through this compartment (from 27 feet to about 16 feet).

Utilization of the main section of the hold would permit holding an additional 344 containers (at least) for about 78% of the bulk storage capacity in that section. This is certainly equal to or better than that obtained using available boxing systems.

3.2.3 Icing/Filling

For the first trip, two boxes in each row of three were filled with ice; the third box held three (3) bags (about 50 kg each) of ice. Ice is the relatively thick "turbo" ice produced in Marystown.

This was found to be too much ice and for the second trip four bags of ice was loaded into each container. The use of bags was found to be reasonably satisfactory. The procedure is as follows:

(a) The system delivers three (3) containers (with ice) to the hatchway.

(b) The bags are removed and dropped 2 or 3 times to loosen up the ice.

(c) The conveyor is started and as fish is directed into the containers, ice is added in the right proportion.

This operation was found by the crew to be much easier than the pen-building and shovelling operations normally used however, bags of ice had to be removed from containers and crushed since the ice hardened quickly to fill the pen type hold. It had been proposed that the ice to fish ratio be gradually reduced to determine the optimum fish to ice ratio. To date, this has not been done.

One of the icing crew stated that the system does not work fast enough. This comment has some validity in that the in-hold and on-deck mechanical systems move at only 0.1 m/s or less which means that the average time to return a set of full containers to the hold and place a set of empties on deck for filling is 3½ to 4 minutes under normal conditions. With manual operation, the fish icer/stower has to be at the controls and cannot perform other functions, such as breaking up ice in the bags which could otherwise be done. The maximum filling rate required to match the gutting rate is approximately 4 tons/hr. Allowing 550 lbs/container, 15 containers will need to be filled every hour which is equivalent to a set of 3 containers every 12 minutes. Subtracting 4 minutes of each cycle for changeover of containers, this leaves 8 minutes to break up ice and stow the fish. This appears to be sufficient time; however, it is relatively easy to speed up the mechanical systems too shorten the changeover time and allow an additional 2 or 3 minutes for icing and filling and it is suggested that this be done. Automatic control will also save a few minutes in each cycle since the operator could initiate the container exchange operations and then proceed to break up the ice (from previous container loads) while the exchange is being made.

In any event, the Contrawl system is designed as an intermittent

system, and for it to work well buffer storage, at least sufficient for the changeover time between one set of full containers and the next set of empties, is essential.

Thus, a minimum of 5 minutes of storage at the gutting rate or about 1,000 lbs. Buffer storage should be provided. It is assumed that this amount of buffer can be readily provided by storing fish on the conveyor belt for the 5 to 8 minutes required delay. If not, buffer storage should be provided in the washer.

Speed of the on-deck lifter and the in-hold horizontal lifter motion have been doubled, reducing the cycle time from the original 3½ to 4 minutes to about 3 minutes.

One equipment option suggested to facilitate icing is an ice hopper/feeder unit. It is suggested this could be mounted at factory deck level so the bags of ice could be readily dumped into the hopper whence an inclined screw feeder would break up the ice and feed it into the conveyor belt with the fish. A sketch of a suggested design is provided in Appendix "C". No action has been taken on this proposal.

A support system is required to stow the top row of containers to maximize hold capacity for fish. Appendix "D" provides a suggested design for the support and feed system for the top layer containers. No action has been taken on this proposal.

3.2.4 Containers

The prototype containers supplied and later foamed with polyurethane insulation by Xactics are rather extensively deformed. These deformations have been caused by outdoor storage over the years, the foaming

operation, a mold construction defect and use at Marystown.

Despite the severe dimensional variations, the mechanical system works remarkably well. To line up the tops of the containers, several long aluminum beams were placed along the edge of the top row of containers (see photo 3, Appendix "B"). It was felt that these beams would be necessary to prevent containers from falling into empty columns (as occurs when the column of containers is moved out for temporary storage and filling). Although the trip was quite rough, there was no apparent indication that the beams are necessary for this purpose. However, beams or container joiners connecting adjoining containers on the short side (see photo 3, Appendix "B") will be necessary at least as long as the existing defective containers are used.

Two or three times during discharge, it was necessary to either wedge the lifter frame into a row of containers to achieve engagement or to lift the end of one of the containers so the lugs could rotate into the lifting holes. New containers would certainly solve these problems.

In transferring containers to and from the vessel by forklift, it was noted that at least one container had jammed into one positioned below it. This problem was caused by rough terrain.

In the holding room, it was noted that when containers are close stacked, it is not possible to pick them up with a standard forklift. Two or three corners of containers were damaged, probably as a result of picking them up on one edge only. Accordingly, containers have to be stacked with about 200 mm to 300 mm space between stacks.

To overcome these and other operating deficiencies and to provide greater strength, new containers have been fabricated with modifications noted in Appendix "E".

Lightweight, uninsulated covers, supplied under the Xactics contract were not used on the first trip and fish in these containers had very little, if any, ice cover at the end of the trip. For subsequent trips, the top layer of containers had covers placed and these reduced the ice meltage considerably. For shipboard use it is suggested that lightweight insulating covers should be made from insulating blanket materials, perhaps fastened with velcro tabs. Such suitable covers will be developed over the next several months, as well as heavier insulated covers for transportation/storage on shore. In any event, it will only be necessary to cover the top containers in a stack.

3.2.5 Safety

The system provides a good, safe environment for the crew. Nevertheless, some potential hazards were noted and should be corrected, as follows:

(a) A ratchet-type latch is suggested to positively engage and support the on-deck lifter in its maximum raised position. This will ensure that, should the cables fail, it cannot fall on workmen filling containers beneath the lifter. Appendix "F" illustrates a suggested method. The method has not been adopted.

(b) A handrail installed along the bulkhead opposite the hatchway provides a grip for workers who might otherwise be thrown off balance above an open hatchway or when peering into the

hatchway to observe operation of the in-hold system, etc.

(c) It was originally felt that sloped covers would be necessary to divert fish or ice outside the hatch coaming from the filling operation. This is not now considered necessary and, to assist workers in the filling and ice bag removal operations, a treadplate was installed above the hatch beam supports and between the hatch coaming and the row of containers. This also prevents a foot from slipping into this opening (See Appendix "G").

(d) Storage should be provided for aluminum container joiners. A plastic container may be suitable for this purpose. No action was taken on this suggestion.

(e) The lifter frames may be used as elevators and/or working platforms for the ship or maintenance crews. Accordingly, they were to be covered with removable treadplates to prevent falling between, etc. while allowing access to drives, etc. for maintenance (See Appendix "H").

(f) Loading and Discharging: The upper deck hoist (see photo, Appendix "B) is used to engage one container at a time for loading or discharge. It had been estimated that a loading/discharge rate of one container every 1.5 minutes could be achieved, but to date the best speed has been about 3.75 minutes per container (equivalent to about 5 tons per hour). To increase this rate and to prevent the corners and edges of

containers from catching on hatch beams, hatch coaming, etc. with the possibility of being jarred loose and falling, it is proposed that a guide system be installed between the upper and lower hatch coamings with lead-in tapers above and below. A suggested design for these guides is provided in Appendix "J". This was tried, but proved unsuccessful and was abandoned.

3.2.6 Tools

To simplify operation and/or to facilitate entry of lifter frames into poorly aligned containers some hand tools, such as pry bars and temporary lifting cords, should be provided. These can be very simple devices and no further description is provided in this report.

On shore, however, filling of ice bags is a very tedious and time consuming operation. We suggest, therefore, that a bag filling method be developed to simplify and speed up this operation. Appendix "K" shows a suggested method. To date, no action has been taken on this suggestion.

Also on shore, the spacing of stacks of containers necessitates considerable extra storage space in the holding room. This is perhaps not important with only 60 to 70 containers, but would be unacceptable with one or two shiploads having to be stored (1000 or more containers). Besides this, the forks of the rotating head fork truck tend to block the flow of ice from the container and delays the emptying process. Again, this is not important with only a few containers, but may be a problem when large numbers of similar containers are used. Accordingly, a special shifter attachment, shown in Appendix "L" is suggested for use with the lift truck. Such an attachment could be provided by forklift

manufacturers if there is sufficient demand.

3.2.7 Controls and Interlocks

To make it more simple to operate and prevent an incorrect decision by a crew member which could cause system damage and to facilitate system automation the Contrawl system has a relatively large number of limit switches and interlocks.

This control system has largely been developed by Mr. L. Walters of DES, under sub-contract with Contrawl. The guiding principal used in the control system development was that the manual system should be simple to understand and operate since automated systems oftentimes fail.

The success of this approach may be demonstrated by the fact that the loading of containers on the first trip was conducted completely by the ship's crew and the discharge entirely by the discharge crew. In the latter case, less than five minutes instruction was necessary.

Nevertheless, because of the complexity of the Control system, good wiring diagrams and clear trouble-shooting instructions will need to be developed by Contrawl for any commercial installation. In addition, in order to reduce problems caused by limit switch failure, most of the limit switches have been changed from mechanical to proximity type.

A listing of limits and interlocks is provided in Appendix "M".

A new, automatic control system has been designed, fabricated and installed. Because of faulty containers still in use on the last trip, no attempt was made to operate the system automatically.

However, with new containers use of the automatic control system will free the operator to break up ice (see 3.2.3) and also reduce cycle

time by eliminating errors in selection of column and centering of the lifter frame.

4.0 IN-PLANT RESULTS FROM CONTAINERIZED FISH

Results of processing fish from the first and second trips using containers have been provided to the Department of Fisheries and Oceans by Fishery Products International. At the time of preparing this report, it is known only that dockside grading of the containerized fish shows it is to be of significantly higher quality than fish of the same age from the same trawler but stowed in pens.

Furthermore, 67% of the eight-day old cod brought in by containers was suitable for premium packs. This compares with an expected average of 30 to 40% for pen-stored cod.

These results were expected and will likely be improved upon by more careful filling and ice procedures.

It is suggested that some effort be made to determine the optimum fish to ice ratio, since the less ice that can be used to achieve the same high quality, the greater the volume of fish that can be stored in each container and the lower the cost of icing.

5.0 FURTHER DEVELOPMENT & COMMERCIAL APPLICATION

The use of large, insulated containers in Newfoundland during the past 10 years has clearly demonstrated advantages of container technology over boxing technology, while delivering fish of equivalent high quality. Since the quality of containerized fish in suitably sized insulated

containers is equivalent to that obtained from boxing, an economic comparison of the Contrawl System with typical boxing systems can be readily made.

The analysis provided in Appendix "N" is intended to compare the economics of operating a fleet of wetfish trawlers using Contrawl Containerization Systems and high speed discharge systems with a fleet of wetfish trawlers using relatively sophisticated boxing systems.

The variable costs included in this analysis are:

1. replacement costs of boxes/containers,
2. raw materials handling and transportation,
3. discharge, clean-up and re-load costs,
4. vessel operating costs, and
5. ice costs.

The fixed costs include amortization of the fleet of vessels required to land a given quantity of fish (400,000,000 lbs./yr.) plus an allowance for other fixed costs which may be considered attributable to vessel operations (shore staff, etc.).

This analysis, summarized in Figure 1 following, is based on reasonable assumptions provided in the Appendix which are favoured over "boxed" trawlers. It illustrates that a fleet of Contrawl-equipped trawlers provides superior performance in all respects, with the possible exception of annual replacement cost of containers (estimated at $420,000 per year higher than boxes) and annual maintenance (estimated at $1,000,000 per year higher than boxes).

Based on this analysis, further development and commercial use of the Contrawl System is clearly indicated.

The next development phase, which it is suggested will be a full

FIGURE 1

		Boxed Trawler		Contrawl Trawler
			$000	
No. of Vessels		44.44		40.04
TOTAL CAPITAL COST:				
- Of Vessels	$457,732		$451,125	
- Of Discharge Facilities	1,200		1,800	
Total Capital Costs	$458,932		$452,925	
Net Sales Revenue (of catch) @ 33 1/3¢/lb. (ave.)		$133,332		$133,332
Less Variable Costs:				
1. Box/Container Replacement	$ 2,000		$ 2,220	
2. Raw Material Transport Cost	$ 1,800		$ 1,200	
3. Raw Material Handling Cost	$ 5,000		$ 4,000	
4. Discharge/Re-Load Cost	$ 2,800		$ 400	
5. Cleaning of Hold	$ 467		67	
6. Vessel Operating:				
- Crew	$ 28,442		$ 23,220	
- Fuel, Maintenance, etc.	$ 22,220		$ 21,575	
7. Ice Costs	$ 2,700	$ 65,428	$ 2,500	$ 59,943
Vessels Operating Margin		$ 67,903		$ 73,389
Less: Fixed Costs		$ 59,383		$ 58,672
NET VESSEL OPERATING PROFIT		$ 8,520		$ 14,717

vessel operation, would provide Contrawl Systems incorporating latest design and operating features which have been or can be deduced from operating the present prototype together with suitable vessel discharge and shore handling systems to achieve the maximum operating potential of the overall system.

During the planning of this next phase, thorough consultations should probably be held with unionized fishermen's representatives to explain the project in detail, discuss how job opportunities may be affected and obtain the support and co-operation of the fishermen and vessel crew.

Some design modifications which could be incorporated in the new systems include:

1. Simplification of drive systems, such as locating drive shaft and chain takeups below the factory deck level and positioning drive gear motors and winches on a common base.
2. Simplification of electrical system by incorporating all (or most) starters and disconnects in a motor control center (MCC).
3. Incorporating higher reliability into the control systems by using proximity switches and solid state control devices (PLCs, relays, etc.)
4. Materials of construction would be selected to reduce maintenance and downtime costs to a low and acceptable level.

Further, the next system, which will still be prototypes to a large extent, should be constructed on a shore as modular systems. Thus, any required design changes, system tests, controls debugging, etc., can be performed prior to installation of the systems on a vessel.

The vessel, if retrofitted, would not be docked and stripped until

final operating tests of the system have been completed. The systems, which will have been built to fit prepared anchor points in the vessel, would then be marked, disassembled and transferred to the vessel for re-assembly and attachment to the deck and hull.

This procedure would save considerable time and cost and eliminate welding stress, inaccuracies and changes in installation which, despite the best of attention, occurred all too frequently during the installation of the present prototype system.

6.0 SUMMARY AND CONCLUSIONS

The Contrawl System offers high potential for optimizing returns from the renewable fisheries resource harvested by relatively large offshore vessels.

While the prototype on the Atlantic Margaret has introduced operational problems (some foreseen, some unforeseen, as described in the text), it has clearly proven that the Contrawl System works well in a very hostile marine environment and does so with safety. Inconveniences being experienced with the prototype can be readily overcome and some low cost solutions have already been identified and described herein. While boxing on board is common in Europe and elsewhere, there can be little doubt that current boxing methods are not entirely satisfactory. On the other hand, the use of containerization over the past 10 years in Newfoundland has clearly demonstrated advantages over boxing, at least with respect to materials handling costs and convenience, while quality would appear to be equivalent to boxed fish. Thus in Newfoundland, containerization is a known, proven and acceptable technology and its

adaptation to vessels should appear to be a natural evolution.

Continuation of the Contrawl System development by outfitting a full vessel with the system and providing suitable shorebased discharge/re-charge and handling facilities is strongly recommended.

PART

2

Scientific Excellence • Resource Protection & Conservation • Benefits for Canadians
Excellence scientifique • Protection et conservation des ressources • Bénéfices aux Canadiens

Contrawl Project

Part II

Fishery Products International

Development Branch
Department of Fisheries and Oceans
Newfoundland Region
P.O. Box 5667
St. John;s, Newfoundland
A1C 5X1

May 1988

Canadian Industry Report of Fisheries and Aquatic Sciences No. 195B

Canadian Industry Report of Fisheries and Aquatic Sciences

Industry reports contain the results of research and development useful to industry for either immediate or future application. They are directed primarily toward individuals in the primary and secondary sectors of the fishing and marine industries. No restriction is placed on subject matter and the series reflects the broad interests and policies of the Department of Fisheries and Oceans, namely, fisheries and aquatic sciences.

Industry reports may be cited as full publications. The correct citation appears above the abstract of each report. Each report is abstracted in *Aquatic Sciences and Fisheries Abstracts* and indexed in the Department's annual index to scientific and technical publications.

Numbers 1–91 in this series were issued as Project Reports of the Industrial Development Branch, Technical Reports of the Industrial Development Branch, and Technical Reports of the Fisherman's Service Branch. Numbers 92–110 were issued as Department of Fisheries and the Environment, Fisheries and Marine Service Industry Reports. The current series name was changed with report number 111.

Industry reports are produced regionally but are numbered nationally. Requests for individual reports will be filled by the issuing establishment listed on the front cover and title page. Out-of-stock reports will be supplied for a fee by commercial agents.

Rapport canadien à l'industrie sur les sciences halieutiques et aquatiques

Les rapports à l'industrie contiennent les résultats des activités de recherche et de développement qui peuvent être utiles à l'industrie pour des applications immédiates ou futures. Ils sont surtout destinés aux membres des secteurs primaire et secondaire de l'industrie des pêches et de la mer. Il n'y a aucune restriction quant au sujet; de fait, la série reflète la vaste gamme des intérêts et des politiques du ministère des Pêches et des Océans, c'est-à-dire les sciences halieutiques et aquatiques.

Les rapports à l'industrie peuvent être cités comme des publications complètes. Le titre exact paraît au-dessus du résumé de chaque rapport. Les rapports à l'industrie sont résumés dans la revue *Résumés des sciences aquatiques et halieutiques*, et ils sont classés dans l'index annuel des publications scientifiques et techniques du Ministère.

Les numéros 1 à 91 de cette série ont été publiés à titre de rapports sur les travaux de la Direction du développement industriel, de rapports techniques de la Direction du développement industriel, et de rapports techniques de la Direction des services aux pêcheurs. Les numéros 92 à 110 sont parus à titre de rapports à l'industrie du Service des pêches et de la mer, ministère des Pêches et de l'Environnement. Le nom actuel de la série a été établi lors de la parution du numéro 111.

Les rapports à l'industrie sont produits à l'échelon régional, mais numérotés à l'échelon national. Les demandes de rapports seront satisfaites par l'établissement auteur dont le nom figure sur la couverture et la page du titre. Les rapports épuisés seront fournis contre rétribution par des agents commerciaux.

CONTRAWL PROJECT

PART II

FISHERY PRODUCTS INTERNATIONAL

DEVELOPMENT BRANCH
DEPARTMENT OF FISHERIES AND OCEANS
NEWFOUNDLAND REGION
P.O. BOX 5667
ST. JOHN'S, NEWFOUNDLAND
A1C 5X1

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MARCH 1987

CONTRAWL PROJECT

BY

FISHERY PRODUCTS INTERNATIONAL LIMITED

FOR

FISHERIES DEVELOPMENT BRANCH
DEPARTMENT OF FISHERIES AND OCEANS
NEWFOUNDLAND REGION
P.O. BOX 5667
ST. JOHN'S, NEWFOUNDLAND
A1C 5X1

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INTRODUCTION

In recent years, Fishery Products International Limited has been searching for a method to land a higher quality raw material by its wetfish trawlers that would require less labour and permit a higher vessel discharge rate when in port. Contrawl Limited approached F.P.I.L. in 1980, presenting a concept to develop the in-hold portion of such a system, and requested support in Contrawl's application for the funding of a full scale prototype under the Enterprises Development Program (EDP). An agreement was reached and the prototype was subsequently fabricated and demonstrated at Colda Mechanical Limited in St. John's. At that time Contrawl Limited was successful in receiving funds under a second EDP program to develop a computerized control system for the prototype.

The prototype demonstration appeared to have much merit but its suitability under trawler operating conditions, and its capability to land an improved quality product, had to be proven. Contrawl Limited then requested F.P.I.L. to enter a joint project with Contrawl Limited and Fisheries and Oceans Canada to install a second generation system onboard one of its existing vessels and test the design under actual sea conditions. F.P.I.L. was to install a system supplied by Contrawl Limited and the installation cost was to be financed by Fisheries and Oceans Canada as per a contract between F.P.I.L. and D.F.O. Any lost contribution during the life of the project was to be absorbed by F.P.I.L.

F.P.I.L. agreed to this arrangement and in 1984 entered into a contract with D.F.O. valued at $211,998.00 to perform the installation

work. This figure was later amended to $311,260.00 and a second contract was finalized in 1985 for the amount of $57,675.00 to finance the operating and maintenance costs to the end of that fiscal year. A third contract was awarded in 1986 to cover the operating costs of an extended testing period up to June of 1986 and also the removal of the system from the vessel and restoration of the trawler to its original condition. That contract was valued at $169,000.00.

The scope of the project, as far as F.P.I.L. was concerned, was to install a fish-hold container storage and handling system onboard a trawler and operate the system for approximately six to eight months to determine if the idea was a workable concept. Problems associated with installing and operating the system were to be noted along with the quality of the landed product as it compared to that of a similar age and specie stored by the conventional penboard and stanchion method. High volume discharging and increased icing of fish were not considered for this project.

F.P.I.L. reviewed its trawler fleet and decided that a vessel from the Marystown fleet would best accommodate the new installation. The Atlantic Margaret was chosen and installation on the vessel was performed during the ship's refit period.

SECTION 1 - DESCRIPTION

The fish-hold of the Atlantic Margaret is divided into two compartments with a total storage capacity of 350,000 pounds of landed product by the penboard/stanchion method. A cross-sectional bulk head forms a forward fish-hold compartment of 70,000 pounds capacity and an

aft compartment of 280,000 pounds. It was decided to install the Contrawl system in the forward fish-hold and maintain the aft hold for conventional type storage. This arrangement would minimize the reduced productivity of the vessel due to volumetric loss of raw material landed and minimize the installation cost but also permit a true test of all components of the Contrawl system under sea conditions.

The forward fish-hold was completely stripped down to the structural steel of the hull, deck head, double bottom tank tops and bulk head. All stanchions, aluminum sheeting, insulation and timber materials were removed and a steel frame was installed to provide support and guidance for the new containers.

The Contrawl installation permitted forty-eight containers to be stored in the forward fish-hold. The system was three containers long and five storage bays wide. The three center bays stored four tiers of containers and the two outside bays stored containers two tiers deep. An extra tier of containers over all five bays and totalling fifteen in number, could have been accommodated if stored elsewhere until filling time. Temporary storage on the factory deck would have been necessary for these containers in order to provide maneuvering space inside the fish-hold when filling the others. The Atlantic Margaret did not lend itself to factory deck container storage.

A bridgeless crane was secured to the deck head of the fish-hold. The crane consisted of two end truck assemblies each rolling on a set of channel irons positioned transversely in the fish-hold. One set of channel irons was located immediately aft of the containers and the other was positioned immediately forward. The trucks were powered by a roller chain driven by a motorized shaft on the factory deck above. The lifter

frame could be lowered onto a row of containers and electrically powered lugs, installed in the lifter frame, would subsequently engage them. The containers could then be lifted and moved to any part of the hold by maneuvering the lifter frame.

The hatchway in the forward fish-hold had to be lengthened. This was necessary because it had to allow three containers, arranged end to end, to pass through simultaneously.

A motorized retractable angle iron was installed in each side of the hatchway. They were installed such that when in the retracted position, a row of containers could pass through the opening and when in the extended position, could be supported by them.

Mounted to the deck head of the factory deck an don centre with the fish-hold hatchway, was a second lifter frame. It too, was suspended on cables and could be lowered to the bottom of the fish-hold. The movement of this lifter frame was also controlled by motorized winches on the factory deck.

The factory deck lifter frame was mounted at the deck head to a retractable frame. The frame was on rollers and could be moved to the starboard side. This was necessary to allow access to a hatchway in the deck head directly over the fish hold hatchway. Containers were transferred between the fish hold of the trawler and the dock through these two hatchways.

A hydraulic crane was mounted on the forecastle deck. The crane was used to load and discharge the containers when the vessel was in port.

A mechanical and electrical room was constructed on the factory deck over the forward fish-hold and to the extreme starboard side. This compartment housed the drive units for the lifter frames and the

bridgeless crane, and most of the electrical switches and control panels.

The operation of the in-hold equipment and the factory deck lifter frame was controlled by an operator using a control console. The console was mounted on the factory deck at the forward end of the fish-hold hatchway. This location gave the operator a good view into the hold.

The console was designed for two modes of operation designated as manual and automatic. When in the manual position, the operator directed each individual equipment movement as he desired. It was important for the operator to have a good view into the fish-hold to see things as they happened. The only feedback that the console displayed was an indication as to when the in-hold travelling bridge was on centre of a storage bay, thus signifying that the in-hold lifter frame was in position for lowering. When the console control was switched to the automatic mode, the system was programmed to perform the proper sequence of movements automatically for storing filled containers and bringing up empties.

The control system utilized a series of sensor switches positioned throughout the fish-hold and factory deck. The sensors fed information to the control panel and provided an interlock system. The interlocks increased the possibility of safe operation and was necessary for automatic control.

SECTION 2 - INSTALLATION

The installation of the Contrawl system was performed at the F.P.I. Limited vessel refit centre in Burin by qualified trades people. The Atlantic Margaret arrived at Burin in January of 1985 and was ready for sea trials in October of that year. In conjunction with the Contrawl

installation, a refit of the vessel took place which included engine work and propulsion system alignment. During the summer period, work was discontinued on the Contrawl system for four weeks when the vessel was moved to a shipyard for underwater work.

It was decided to do the installation at the Burin refit facility for economic reasons. The estimated cost to perform the work at Burin was substantially less than quotations received from shipyards. In addition, the design package for installation was very general which meant that much of the detail had to be worked out in the field. This is probably not uncommon for a project of this nature, but it would be very difficult to control extra job costs if a contract had been awarded to an outside contractor.

F.P.I.L. installed major equipment items as supplied by Contrawl Ltd. This included:

1. electrical control panels
2. electrical sensor switches
3. factory deck lifter frame and retractable beam units
4. in-hold travelling bridge system and lifter frames
5. motorized winch units and spring loaded blocks
6. containers

F.P.I.L. supplied all other materials which included:

1. all plate, structural steel and miscellaneous metals
2. common electrical switches, lighting and wiring
3. small motors and gear boxes
4. miscellaneous materials such as plexiglass, cable, wood, fasteners, paint, etc.

Materials were selected in a cost conscious manner and for

relatively short term application. For this reason, steel was used as the primary fabrication metal for the in-hold container guide system, overhead travelling bridge and lifter frames. In an installation for long-term use, steel would have to be substituted for a non-corrosive metal.

Before installation began, F.P.I.L. inquired about the suitability of certain design components related to the electrical controls system. Contrawl intended on using lever and push button activated sensor switches as part of this installation with magnetic relay switches in the control panels. F.P.I.L. had little faith in these components for such a severe working environment. At that point, however, the components had already been purchased and extra cost would have been associated with replacing them, so it was decided not to make a change. Later in the project, these items proved to be a constant source of problems. It was the desire of F.P.I.L. to use proximity limit switches and programmable logic controllers for these applications.

SECTION 3 - OPERATION

When at sea, the on-deck lifter was secured in place over the fish-hold hatchway. To load containers, the operator at the console maneuvered the in-hold bridge and lifter frame to pick up a set of three containers and deposit them in the center bay directly under the hatchway. The in-hold bridge and lifter frame was then moved to the side and the on-deck unit lowered down to engage the containers. The lifter frame nestled down between the raised side walls of the containers and the motorized lugs installed in the lifter frame were actuated. The lugs extended out

through slotted holes formed in the raised sides of the containers, thereby taking the weight of the containers when the lifter frame was raised. The containers were then raised up through the factory deck hatch coaming and the motorized angle brackets moved into position out into the open hatchway. The three containers were then lowered to rest on the angle brackets and the lifter frame disengaged and raised up tight to the deck head.

At that point, the containers were positioned partially through the hatchway and such that the tops of the containers were several inches below the belt of the factory deck conveyor which ran parallel beside the hatchway and carried fish. Fish was directed from the conveyor through one of three gates and down a short chute into the containers.

When the containers were loaded on board the vessel in port, 50 pound bags of ice were placed in each container. Before fish was directed into the containers, crew members removed the bags of ice. A layer of ice was spread over the floor of each container, ice was mixed evenly through the fish as the containers were filled and a top layer of ice was spread over the fish. The containers were then stored and another three positioned for filling.

When the vessel was in port, the hydraulic crane mounted on the forecastle deck was used to transport containers between the fish hold and the wharf. An operator using controls mounted near the base of the crane handled one container at a time.

SECTION 4 - OPERATING RESULTS

The Atlantic Margaret went back into service on October 20, 1985. Five fishing trips were made before the Christmas tie-up and then an additional fourteen trips in the new year up to June of 1986. During the vessel's first five trips, a number of problems were experienced. A list was prepared in an effort to rectify them when the vessel was in port during the Christmas break. Deficiencies identified during that period were as follows:

(a) The containers had warped and bulged out of shape considerably after little usage, such that it was very difficult for the lifter frames to engage properly without the help of crew members using pry bars. It was concluded that a stronger container, manufactured to closer tolerances, would be required. The lifter frames needed to be tapered to secure proper alignment. As an interim measure, before better containers could be provided, aluminum brackets had to be fabricated. These would be used to hold the containers in line during the lifter frame engagement process.

(b) There were not enough drainage ports in the containers to drain ice melt water when at sea.

(c) Outside corners of containers were being damaged during the lowering into the storage bay structural guides. A number of factors could have contributed to this problem.

1. The need for sensor switch adjustment.

2. The in-hold guide columns were not installed perpendicular to the main longitudinal girders of the ship as directed by the consultant. This alignment produced extra scrubbing on the areas of the containers in contact with the aft columns.

3. Roughness of cut on the tee sections fastened to the main columns.

4. The need for a better guide system in the transition phase of lowering the containers from the on-deck guides to the in-hold guides.

(d) The speed of the bridgeless crane and lifter frames needed to be increased.

(e) A footrest and handrail was required on the factory deck along the fish hold hatch coaming to aid crew members.

(f) The lever and push button switches were corroded and seizing up. They needed to be replaced by proximity devices.

(g) Some switches needed to be adjusted and one relocated to a more protected location.

(h) The Automatic operation mode was not working.

(i) The trolley car system supporting the electric power supply to thin-hold lifter was binding and damaged.

(j) The two winches on the factory deck controlling the lifter frame movements each needed a guide-on mechanism. Without it, improper wire wrap on the drums was common and resulted in lifter frame malfunctions.

(k) Sheaves and bushings on the in-hold bridge and lifting frame were seizing up and no provision for lubrication existed. The system had to be disassembled, grease nipples installed and lubricated.

(l) Holding pins for securing the on-deck lifter could be easily damaged with the existing method of moving the frame from port to starboard.

(m) Electrical relay fell out of position.

(n) Intermittent control board malfunctions which appeared to be caused by ship vibration and possibly moisture contamination.

Most of the above problems were addressed during the Christmas tie-up. The intermittent electrical problems, however, which were inherent in the control system, were not rectified; the containers could not be replaced with better ones and guide-on units could not be installed on the winches.

In the early trips of 1986, the Contrawl system was operated continuously but was constantly plagued with the problems associated with those things that could not be corrected during Christmas. Contrawl Ltd. contracted its supplier to have a better container manufactured and also directed its controls designer to assemble a new electronic board. The new board was intended to eliminate the intermittent electric problems in the control panel and also make the system operable in a semi-automatic mode. In addition, proximity switches were installed to replace the push-button and lever type devices.

The new containers, proximity switches and electronics board all proved very effective in reducing the frequency of the problems but did not eliminate them completely. Operation of the system in any mode other than manual was never realized.

Operating the contrawl system was a new experience for F.P.I.L. operations personnel, different in many ways from their normal duties. The transfer of containers between the wharf and the fish hold required

the services of five people at the vessel and a forklift operator to transport containers between the vessels and the dockside. A man was required inside the fish hold to attach the lifting bracket of the loading crane to containers. A second person was required to operate the factory deck control panel. Two people were necessary on the forecastle deck, one as the crane operator and the other to ensure proper container alignment when a container was passing through the hatchway. A fifth person was required on the dock to align containers properly on a pallet and manipulate the lifting bracket of the loading crane.

Initially, it took four hours to load the containers on board the vessel but this improved to 2½ hours when the workers became more familiar with the system. The discharge time was initially three hours but it was eventually improved to two.

When at sea, two crew members were required to work the system. One was required to operate the control console and a second to fill the containers with fish and ice. In a penboard/stanchion system, one may only is used under normal circumstances. He works in the fishhold.

When a continuous supply of fish is available, it took an average 9½ minutes to load a set of three containers with fish and ice. It took an average of 11 minutes to search out a set of containers and position them for filling and about 4½ minutes to store filled containers.

These time studies were performed before the Christmas tie-up. The installation of the larger drums on the winches reduced the maneuvering time for containers by approximately one third (4mm to search out and position containers in the hatchway for filling).

Under the normal method of operation, a vessel such as the Atlantic Margaret has the ability to store approximately 6,500 pounds of head-on and gutted cod per hour. This figure varies with size of catch and time

of year.

The ice-to-fish mixture in the Contrawl containers, for most of the test period, was maintained at the conventional standard of 2/3 fish and 1/3 ice. Approximately 200 pounds of ice was loaded into each container in port and approximately 525 pounds of head-on and gutted cod was landed per container. Later in the project, the amount of ice stored in each container was reduced to 150 pounds. This had no noticeable effect on landed quality but increased the volume of raw material landed proportionately.

During the test period, it was necessary to have a maintenance person in attendance at all times when the system was being operated. This was required both when the vessel was at sea and in port. The maintenance person was required to resolve system malfunctions that could not be corrected without the installation of new equipment pieces and the incurrence of considerable downtime.

The Atlantic Margaret often encountered very heavy seas in storm conditions during the test period. The system proved to be structurally sound and was not impeded by heavy seas any more than other conventional methods of in-hold fish handling and storage. It was operable for the entire test period in that it did not have to be taken out of service. It would, however, have been impossible to use the system without the full-time services of a maintenance man and the extra efforts of the ship's crew in assisting with misalignment problems.

SECTION 5 - PRODUCTION RESULTS

The Contrawl system was used for a total of 19 trips beginning in October 1985 and ending in June 1986. Production results (yields, labour

costs, packout, etc) were compared between penned and containerized fish. These comparisons may contain minor anomalies when production of a vessel's catch occurs over a two day period. To eliminate these possible anomalies, strictly controlled tests were performed for Contrawl trips number 2, 3, 31 and 15. For these trips, the Production system was altered to ensure that containerized fish and penned fish were produced in a strictly confined area using the same production lines, cutters, etc. The conclusions are as follows (all results are for cod only):

Yields - Cod

	Contrawl	Pens	Variance
Wetfish Yields	38.6%	36.9%	1.7%
Freezer Yields	37.3%	35.7%	1.6%

The average count of the containerized fish was 32 versus a count of 33 for the penned fish. This minor difference would not affect yields.

"Frozen Yield" figures should be used in analyzing results. These results indicate that a catch of 300,000 lbs. in a containerized vessel would result in 111,900 lbs. of finished product versus 107,100 lbs. from a penned vessel.

On an annual basis, assuming the average ice-strengthened vessel lands 6 million lbs., containerized fish will result in an extra 96,000 lbs. of finished product. The market information needed to analyze the affect this has on corporate profit is outlined in the next section ("Packout"). Note that the raw material costs of this extra production is effectively nil since, naturally, there is no increase in the purchase cost of the raw material as a result of this increased output. This fact

merely confirms the significant effect that increased yields have on corporate profitability.

Prices

The purchase price of trawler cod is based on a transfer system whereby the vessel "sells" the fish to the Production Department at a breakeven price. The cost of landings include crew costs (shares, per diems, benefits, etc.) and operating costs (gear, maintenance, fuel, etc.). It does not include fixed costs (refit, depreciation, interest, dockings, etc.). An industry average should be used to determine raw material costs.

A. Packout

Containerized fish resulted in a greatly improved pack split between fillet and block production, i.e.

	Block Production
Contrawl	48.8%
Penned	65.7%
Variance	16.9%

Block production as a percentage of total cod production varies widely, especially on a seasonal basis. The reasons for this are well documented. The percentage of block production stated above (65.7%) is not necessarily indicative of F.P.I.L's annual results. The variance, however, would be expected to remain relatively consistent and it is this variance that is important for purposes of analysis.

Increased Revenue Resulting from Increased Fillet Production

Present market conditions are such that in many cases the production of block will yield higher returns to processors than will the production of fillet packs. The existing (24/9/86) block price of $1.50 U.S. - as per the Boston Bluesheet - combined with lower production prices of block tends to minimize or negate the comparative profitability of fillet production. This situation is misleading in that it neither reflects long-term price trends nor reflects the industry's objective of maximizing fillet production while at the same time maximizing the quality of cod blocks.

Historic price differentials vary greatly. Blocks and premiums 5's have varied by 35 - 65 cents/lb. in the last five years. It would appear that any analysis of fillet vs. block production should be based on this price variance.

Quality Results

Quality grading is based on four criteria: texture, bruising, blood clots and odour. The lowest rating in any one of these criteria determines the overall rating of any sample. Since texture is the only criteria affected by containerization, quality grading results can be misleading if used in analyzing the Contrawl project. A more meaningful analysis is to isolate improvements in the texture component only. Results of the Contrawl experiment with regards to texture improvement are as follows:

	Contrawl	Penned
Grade A*	66	40
Grade B	33	56
Grade C	1	4
Reject	--	--

*Contrawl results varied from 48 - 90% Grade A. Penned fish varied from 22 - 66%.

Labour Costs

There are four main cost centers/components in the production of groundfish within F.P.I.L., i.e.:

Receiving Cost Centre: discharge and related functions

Round Fish Cost Centre: cutting and related functions

Special Preparation Cost Centre: trimming and related functions

Fillet Cost Centre: packing and related functions

Results of the Contrawl experiment are as follows (cents/lbs.):

	Contrawl	Penned	Variance
RCC	2.0	.9	(1.1)
RFCC	12.6	14.8	2.2
SPCC	5.5	5.9	.4
FCC	3.8	3.9	.1
Benefit/O.T	5.5	5.6	.1
Total	29.4	31.1	1.7

Comments

A. RCC

Extra workers (signalman, forklift operator, etc.) were required. Refinements to the Contrawl system may result in the reduction in discharge related costs (increased overhead?).

B. RFCC

The filleting process also includes pin-bone removal and skinning. Improved texture therefore would have the greatest affect on this cost centre.

While this report evaluates only cod production, it should be noted that results of boxed flounder production at Catalina have shown that labour costs are lower for boxed flounder than penned. A similar result would be expected for containerized fish.

C. SPCC

Improved texture results in lower labour costs. A recent memo from D.F.O. requests the effect that containerized fish has on work content. For purposes of terminology clarification, texture is not a factor in establishing "work content" under the F.P.I.L. system although it obviously does affect labour costs.

D. FCC

The cost centre is not affected by texture.

Production Results - Conclusion

Improved production results through the use of a Contrawl system are evident as stated in the preceding paragraphs. The Contrawl experiment at Marystown has quantified a previously known fact - containerized fish results in lower production costs and higher quality finished product than does the traditional penned fish. In the final analysis, however, a comparison must be made between containerized fish and boxed fish.

Since the Contrawl was first proposed, F.P.I.L. has boxed 13 of its penned vessels and is rapidly moving towards a fully boxed fleet especially since the results of boxed flounder production have proven very favourable. The next section of this report addresses the comparison between boxing and containerization.

B. Boxing vs. Contrawl

Marystown does not have any boxed vessels and consequently there were no controlled tests to compare the Contrawl results with boxed fish. The production related improvements attributable to boxing are well documented within F.P.I.L. so that it is possible to make a general comparison between the two systems. The Contrawl results were reviewed with Production/Incentive Staff at Catalina and the following conclusions were made:

1. Yields

An overall cod yield increase of 1.6% is readily attainable with boxed fish. Yield improvements vary depending on seasonally, areas, etc. but the overall result is that yields from boxed fish are at least as good as those from Contrawl.

2. Packout

The increase in premium pack production was much better than expected. A thorough review of results from boxed vessels indicates that similar results are attainable with boxed fish.

3. Labour Costs

A. Discharge

The cost of discharging boxed vessels is 4½ cents/lb. vs. 2 cents for containers. Any comparison, however, should take into account the fact that the existing method of discharging boxed fish is temporary and will be made more efficient when the proper infrastructure is implemented.

It is possible to accurately compare labour costs. One reason for this is that v-cuts at Catalina are often performed in the special preparation cost center. The Incentive Manager at Catalina has confirmed, however, that the overall cost reduction realized from containerized fish is readily attainable with boxed fish.

Conclusion

Containerized cod does not result in better production costs when compared with boxed fish. For this reason, the deciding factor in

determining whether or not Contrawl is preferred over boxed fish will probably be based on potential improvements in vessel turnaround. This topic is discussed in the next section.

C. Vessel Turnaround

Previous Contrawl reports have created several misconceptions regarding F.P.I.L's vessel turnaround. The 1983 report by Wayne Follett correctly stated that the existing average in-port time was 96 hours. This statement, however, implies that there is significant potential to reduce this time to 28 hours through improved discharging of Contawl fish. The following breakdown of average 1986 turnaround indicates that avoidable delays account for 102 hours per trip.

	DOWNTIME/TRIP To August 8th, 1986	
	Hours	Days
Fishing Hours	170.5	7.1
In/Out Hours	45.5	1.9
In-Port Hours	48.0	2.9
Operating Hours	264.0	11.0
DELAYS		
Discharge	3.4	.14
Icing	1.7	.07
Landed Early	5.1	.21
Avoidable Delays	10.2	.42
Maintenance	1.6	.07
Maintenance - Unusual	18.2*	.76
Other Unavoidable	11.2	.47
	31.0	1.30
Sub-Total: Delays	41.2	1.72
EXTRAORDINARY		
Tied-up	17.1	.71
Refit	16.2	.68
Docking	5.4	.23

* Excluding Ramea: 13.0

	DOWNTIME/TRIP To August 8th, 1986 Hours	Days
EXTRAORDINARY (continued)		
Christmas	7.3	.30
Ice-Strengthening	5.6	.23
	51.6	2.15
Total Delays	92.8	3.87
Total	356.8	14.87

As this analysis demonstrates, only 10.2 hours per trip are "avoidable" and therefore subject to improvement. However, reduced maintenance downtime is being achieved through the installation of preventative maintenance programs and the replacement of older vessels with new constructions, therefore, the contribution of a system that enables quick vessel turnaround will be significant.

As well, as 36-hour turnaround pilot project has been negotiated with our Union for the port of Marystown and if successful, will be applied throughout the fleet. Hence, the need for a system to effectively provide F.P.I.L. with a consistently efficient turnaround operation. Even without reduced downtime hours and a 36 hour contractual obligation we can still realize 46.4 additional trips annually if the 10.2 hours are recovered. This is the equivalent of two vessels' operations. The cost of constructing a new ship in 1987 as per F.P.I.L. requirements is $8.5 million.

CONCLUSIONS

The Contrawl prototype is structurally sound and has proven to be a workable concept under sea conditions. Just as importantly, the system (containers) can deliver a high quality raw material. However, it is not refined enough in its present form to be considered as a permanent installation onboard a trawler. If Contrawl Ltd. can provide a second generation system that meets industry requirements, then it could serve as a basis on which to design a new ship. It does not appear to be feasible for use on existing F.P.I.L. trawlers. For a full system to be incorporated into an existing vessel, it is anticipated that very extensive and costly modifications would be required and volumetric reduction factors would be too extreme.

The Contrawl system, as it exists today, appears to require more design refinement. It is believed that more involvement by machine design people and industrial control specialists would significantly enhance the product.

When evaluating a new product for service, other factors have to be considered besides the capability of a piece of equipment to perform its specific function. It has to interface with existing facilities and in the case of the Contrawl fish-hold container handling system, its compatibility with present day onshore handling and storage facilities has to be considered. Questions need to be answered regarding the general arrangement of a containerized vessel and what equipment would be needed to handle the existing and projected flow rates of raw materials at sea and in port during the discharge operations. These questions need to be addressed in some detail with consideration for proper icing and

personnel requirements.

F.P.I.L. has demonstrated its commitment to the development of an automatic containerized handling system that delivers a high quality raw material to processing facilities and provides the user with a very efficient unloading system that generates increased sea time.

F.P.I.L., as is most of the fishing world, is still committed to projects related to improved handling of seafood. Fishing vessels are becoming very expensive to build and operate. Improved productivity through increased sea time and greater landings is required if we are to remain competitive.

The existing system can be significantly improved upon with direction and commitment from professional groups with experience in their respective fields. Therefore, F.P.I.L. would seriously consider further participation in this project so long as the proper expertise is applied and financial commitment is given from other project participants.